2.1 INTRODUCTION

E-R model is used to design an initial database design. It provides a concept that allows the database designers to move from an informal description of what user want from their database, to a more detailed and precise description that can be implemented on a DBMS.

E-R model is a high level conceptual data model that depicts the overall logical structure of a database. It is based on the perception of a real word that consist of a collection of object called entities and relationship that exist among those objects.

Advantages

- Simplicity: ER Diagram is easy to use with client if the client has little knowledge about computing.
- Visual Representation: ER Diagram provides a clear high level view of proposed database.
- Effective communication: High level view provides easy communication with client.
- Ease of mapping to relational model: ER Diagram can be easily mapped to relational model.
- Focus on model: Allows database designer to focus on complete and accurate modelling of enterprise without thinking of implementation details.

Disadvantage

- No industry standard for developing an ER diagram.

2.2 BASIC E-R CONCEPTS

(GGSIPU, 2009; PTU, 2010)

2.2.1 Entity

Any object in a real world that can distinguished from other object is called an entity.

Example: In a bank each individual customer, their accounts are object entity.

2.2.2 Entity Set

It is a set of entities of the same type that share same properties or attributes. Similar type of entity are grouped together in an entity set.

Example: In a class each individual student can be identified by Roll No., Name, Branch, Date of birth, etc. i.e. they are having some common attributes, so they can be grouped into an entity set named student.

Example: Each individual employee in an organisation also has some same common attribute like employee no., name, designation, etc. so they can be represent as entity set employee. This is represented by a rectangle in E-R diagram.

Fig. 2.1: Entity Set

2.2.3 Attributes

(GGSIPU, 2009)

They describe the property or characteristic of an entity. It is represented by a Ellipse in E-R diagram.

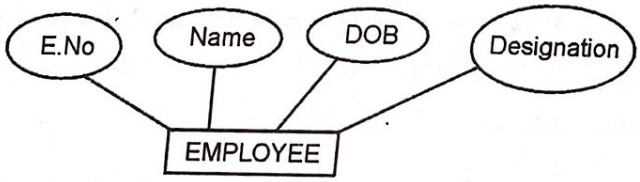


Fig. 2.2: Entity Set and Attribute

E. No., Name, DOB, Designation are the attributes of an employee entity. Attribute can be classified as:

1. Single valued attribute

An attribute that can take only a single value is called single valued attribute.

Example: In the above diagram, there can be only a single value for DOB as one employee cannot have two DOB.

2. Multi-valued Attribute

An attribute which can take more than one value is called multi-valued attribute.

Example: An employee can have zero or one or several telephone numbers. This is represented by double ellipse

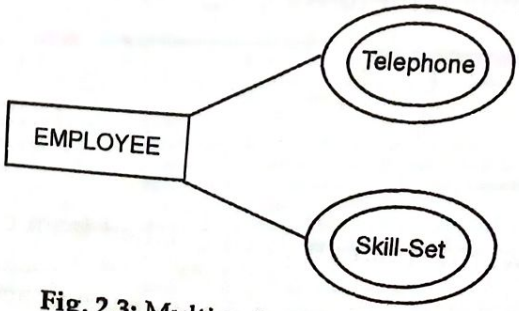


Fig. 2.3: Multi-valued Attribute

3. Simple and Composite Attribute

A simple attribute is one which cannot be divided into sub-parts whereas a composite attribute can be further divided into sub-parts.

Example: Attribute address can be further subdivided into city and state, then city can be further divided into block and street etc.

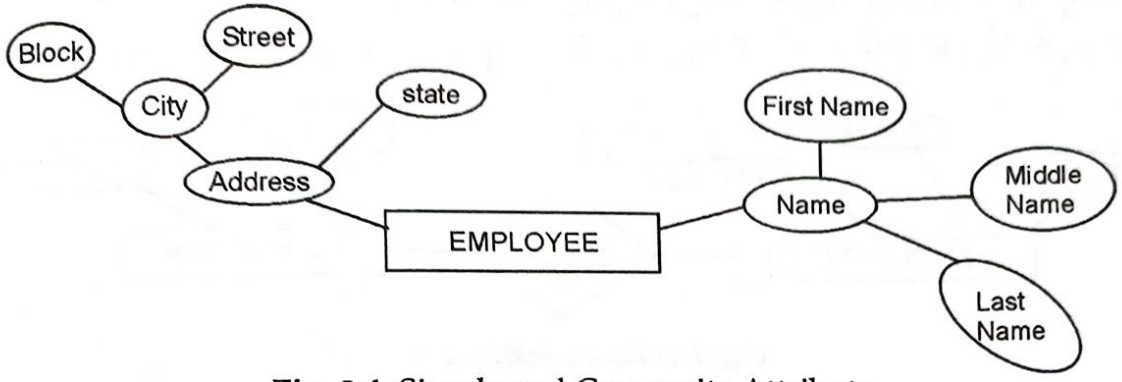


Fig. 2.4: Simple and Composite Attribute

4. Derived Attribute

These attributes are derived from some other related attribute from a set of attributes, not essentially in the same entity set.

Example: The value for age attribute of entity employee can be calculated from DOB attribute. It is represented by dotted ellipse.

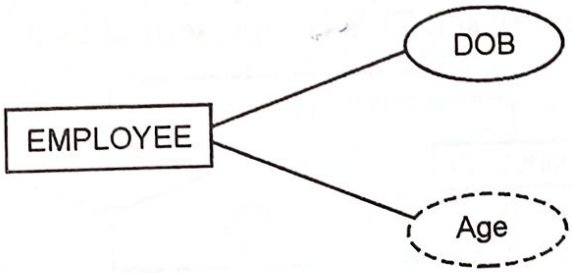


Fig. 2.5: Derived Attribute

5. Key Attribute

A key attribute is also known as identifier attribute. For uniquely identifying each entity in an entity set, one or more entity attributes can be made as key (identifier) attribute.

Example: Each employee in an employee entity set can be uniquely identified by E_No. attribute, as no two employee can have same employee no. A key attribute is represented by underlining the attribute name.

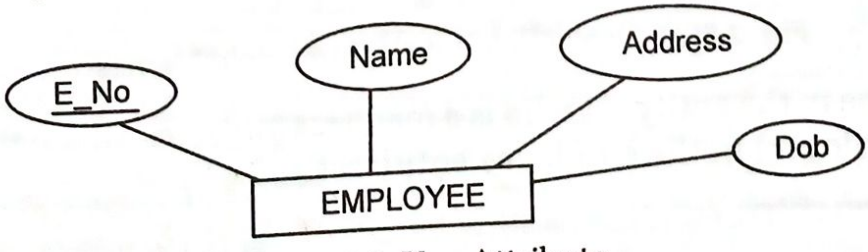


Fig. 2.6: Key Attribute

2.2.4 Relationship

A relationship is an association among two or more entities i.e. how two or more entities are related to each other.

This is represented by a diamond shape box and is joined by lines to the entities that participate in the relationship.

Example: Relationship among employee and department entities may be that employee works in a department.

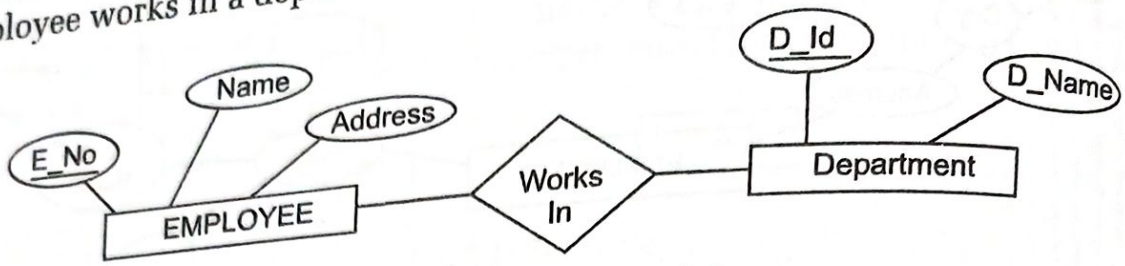


Fig. 2.7: Relationship Set

Degree of Relationship

(MDU, May 2012)

Unary Relationship

Unary Relationship are also known as Recursive Relationships. It is a relationship between the instances of a single entity type. It is a relationship type in which the same entity type is associated more than once in different roles.

Example: An employee in entity set employee manages all other employees belonging to the same entity set. This is represented as follows:

Fig. 2.8(a): Unary Relationship

A relationship can be named to signify its purpose. **Role names** are important to determine function of each participant.

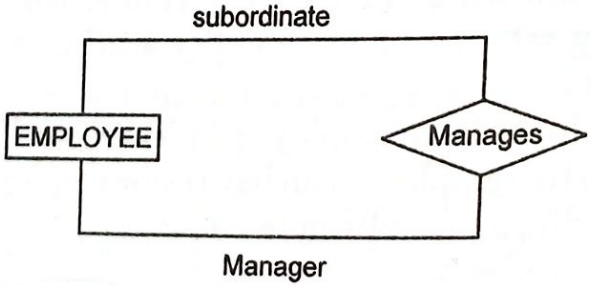


Fig. 2.8(b): Unary Relationship and Role Names

An employee in the entity set who is a manager manages all other subordinate (remaining employee) in the employee entity set.

Binary Relationship

The association between two different entities is called binary relationship.

Example:

Fig. 2.9: Binary Relationship

Ternary Relationship

An association among three different entities is called ternary relationship.

Example:

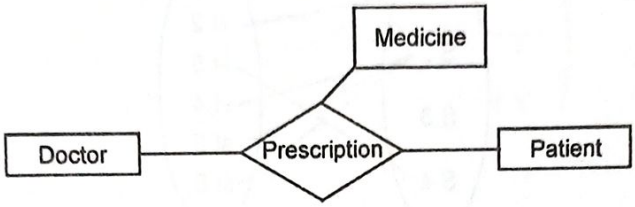


Fig. 2.10: Ternary Relationship

2.3 MAPPING CARDINALITIES

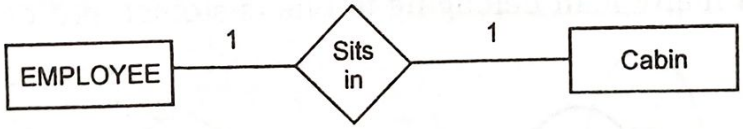
(GGSIPU 2012; MDU Dec. 2009, May 2012)

It represents the number of entities to which another entity can be associated via a relationship set.

One-to-one Relationship (1:1)

An entity in entity set A is associated with atmost one entity in entity set B and an entity in entity set B is associated with almost one entity in entity set A.

Example:



A single employee sits in his own single cabin and cabin belong to a single employee.

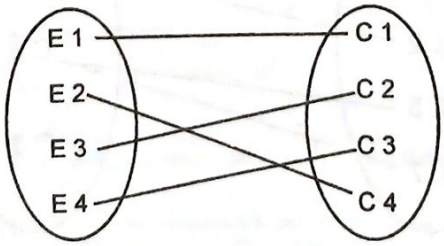
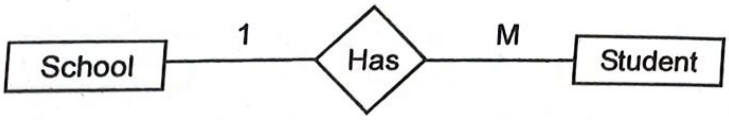


Fig. 2.11: One to One Relationship

One-to-Many Relationship (1:M)

An entity in entity set A is associated with any number of entity in entity set B and an entity in entity set B is associated with atmost one entity in entity set A.

Example:



A school may have many student and many students can belong to a single school.

Example:

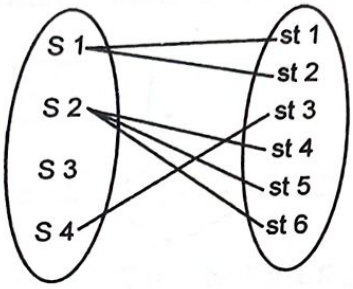


Fig. 2.12: One to Many Relationship

Many to One (M:1) Relationship

An entity in entity set A is associated with atmost one entity in entity set B and an entity in entity set B can be associated with any number of entities in entity set A.

Example:

There can be many loan belonging to one customer and one customer can take many loans.

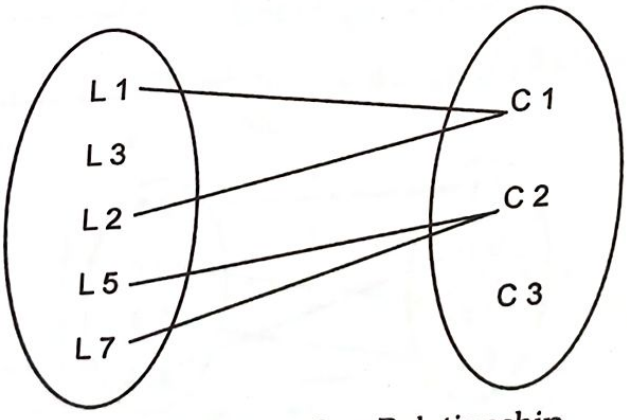


Fig. 2.13: Many to One Relationship

(PTU 2009)

Many-to-Many Relationship (M:N)

An entity in entity set A is associated with any number of entities in entity set B and an entity in entity set B is associated with any number of entities in entity set A.

Example:

A student may be taught by many teachers and a teacher teaches many student.

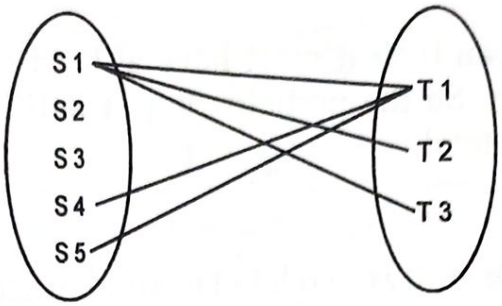


Fig. 2.14: Many to Many Relationship

2.4 DESCRIPTIVE ATTRIBUTE

(GGSIPU, 2013)

A relationship can also have attribute called descriptive attribute. They are used to record information about relationship rather than any one of the participating entities.

Example:

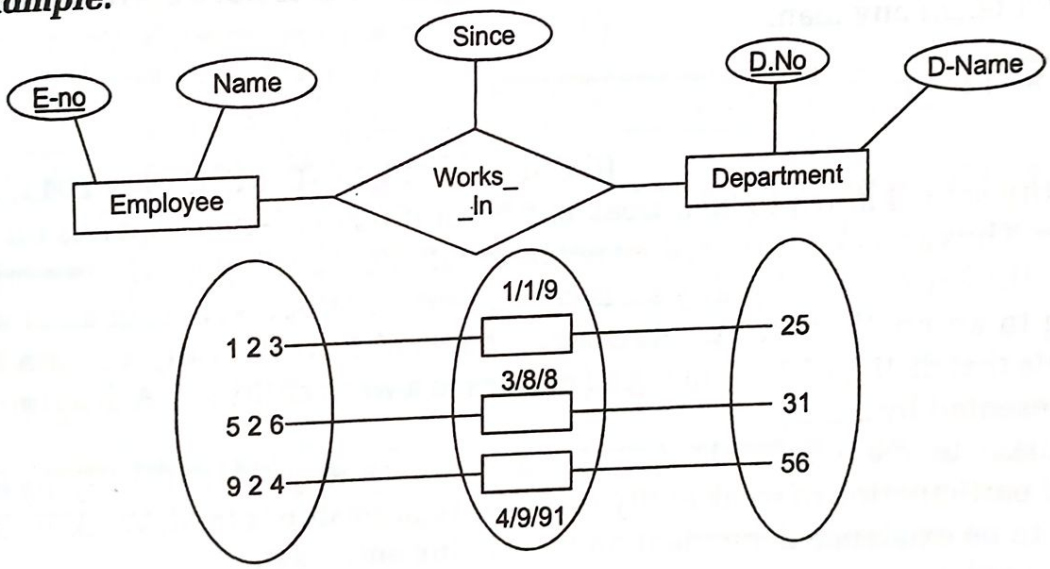


Fig. 2.15: Descriptive Attribute

To capture the information of Disha with E_No. 123 who works in Department 25 as of 1/1/91, 'Since' attribute can be added to relationship Works_In.

2.5 TOTAL PARTICIPATION

(GGSIPU, 2013, 2010)

Each entity in entity set occurs in at least one relationship in that relationship set. This is represented by ═══ (double lines).

Example:

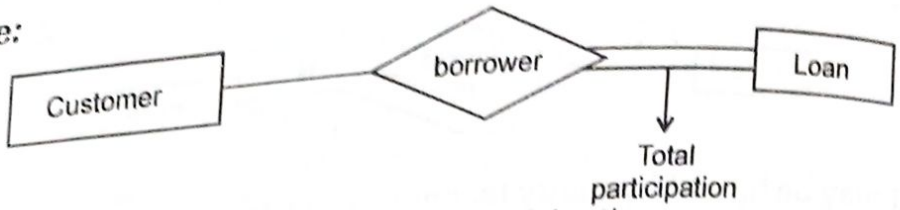


Fig. 2.16: Total Participation

If there exists any loan then it must have at least one associated customer who has taken that loan. So the participation of entities in Loan entity set in relationship borrower is total.

Partial Participation

Some part of the set of an entity are related to another entity via relationship but not necessary at all.

Example:

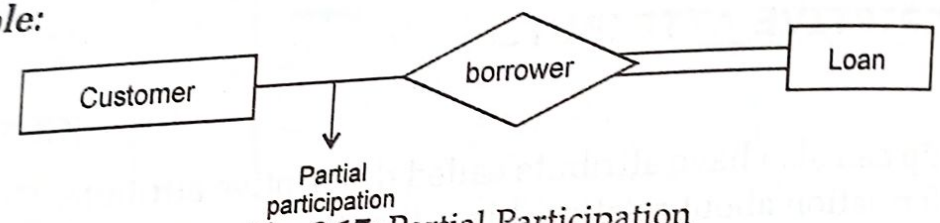


Fig. 2.17: Partial Participation

There can be a customer in customer entity set who is not a borrower i.e. they have not taken any loan.

2.6 WEAK ENTITY SET

(GGSIPU, 2013, 2010; MDU May 2011, 2012)

An entity set is known to be a weak entity set if its existence depends on other entities. Thus a weak entity set does not have sufficient attributes to form a primary key. So the key of a weak entity set is composed of attributes some or all of which belong to an another entity set. Discriminator of a weak entity set is a set of attribute that distinguishes among all entities in a weak entity set. A discriminator is represented by – – – .

A many to one relationship exists from a weak entity set to identifying entity set and participation of weak entity set in the relationship is total. Weak entity set is said to be existence dependent on identifying entity set.

Example:

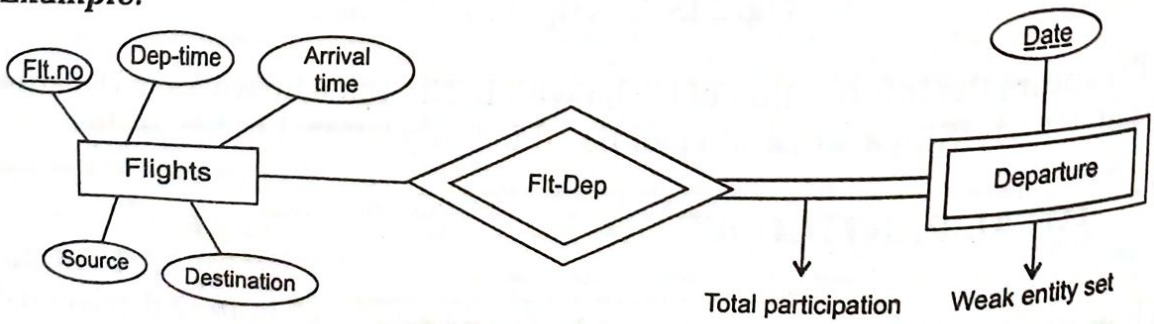


Fig. 2.18(a): Weak Entity Set

Entity set Departure is a weak entity set because different flight may have departure on same day. So, Date attribute cannot uniquely identify departure. But attribute date combined with the primary key of its identifying entity set can surely from the primary key of departure because each instance of Flt_no. + Date uniquely identifies each departure. Therefore primary key for Departure will be [Flt_no, Date]

Now consider the following E-R diagram.

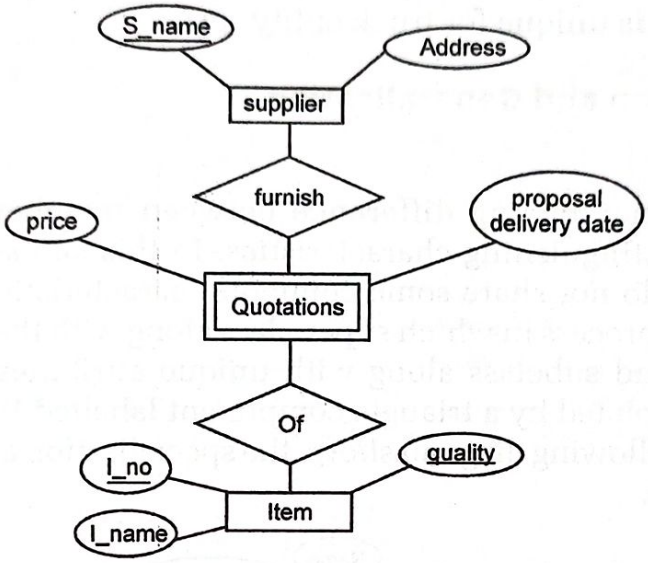


Fig. 2.18(b): Weak Entity Set without Discriminator

Primary key of Supplier (S_name, Address)

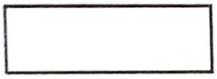
Primary key of Item (I_no, quality)

As there is no discriminator of weak entity set quotation so, primary key is formed by primary key of two owner entities.

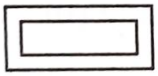
Therefore primary key of weak entity set Quotation: (S_name, quality, I_no.)

2.8 NOTATION FOR ER DIAGRAM

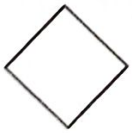
(MDU, May 2009, 11; KU, 2005; PTU 2010, 2009)



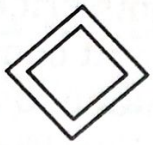
Entity



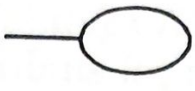
Weak Entity



Relationship



Identification Relationship

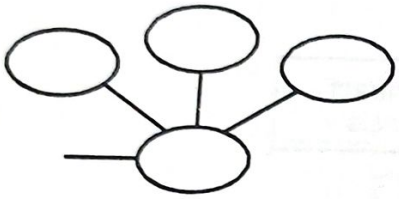


Attribute

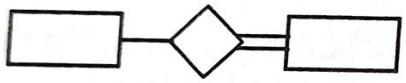
Key Attribute

Multivalued Attribute

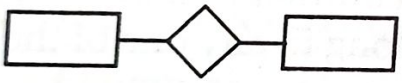
Derived Attribute



Composite Attribute

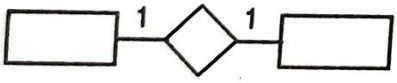


Total Participation



Partial Participation

Specialization on Generalization



One to One Relationship

One to Many Relationship

Many to Many Relationship

Example 1: Construct an E-R diagram for the following description.

- Bank have customers
- Customers are identified by name, cust-id, phone no., address
- Customer can have one or more accounts. Account are identified by acc no., acc type (saving, current), balance
- Customers can avail loans
- Loans are identified by loan id, loan type (car, home) and amount
- Banks are identified by a name, code, address of main office
- Banks have branches
- Branches are identified by a branch no., branch name, address
- Account and loans are related to bank's branches

Ans:

Entities are Bank, customer, branch, account, loan.
Relationship – Bank has branches → 1:N
Branch maintain accounts → 1:N
Branch offer loans → 1:N
Account held by customer → M:N
Loan availed by customer → M:N (Assume one loan can be jointly held by many customers)

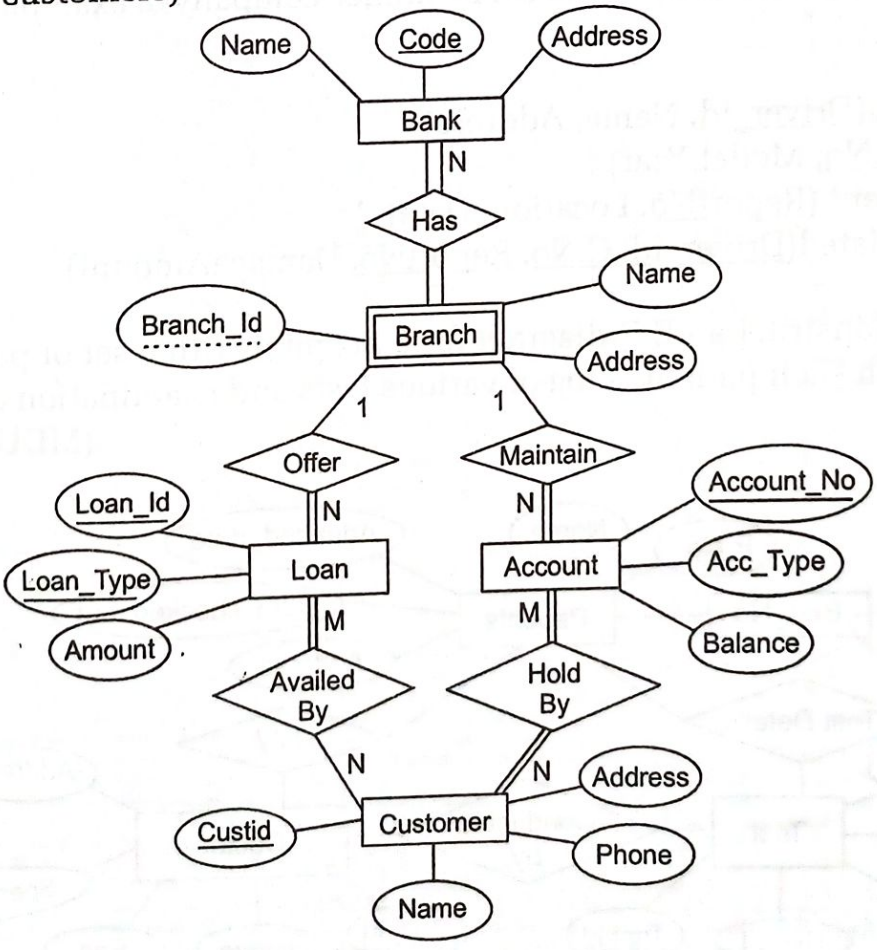


Fig. 2.43: ER Diagram of a Bank

Example 2: Construct an E-R diagram for a car insurance company whose customer own one or more car each. Each car is associated with zero to any number of accidents. **(MDU, May 2009)**

Ans.:

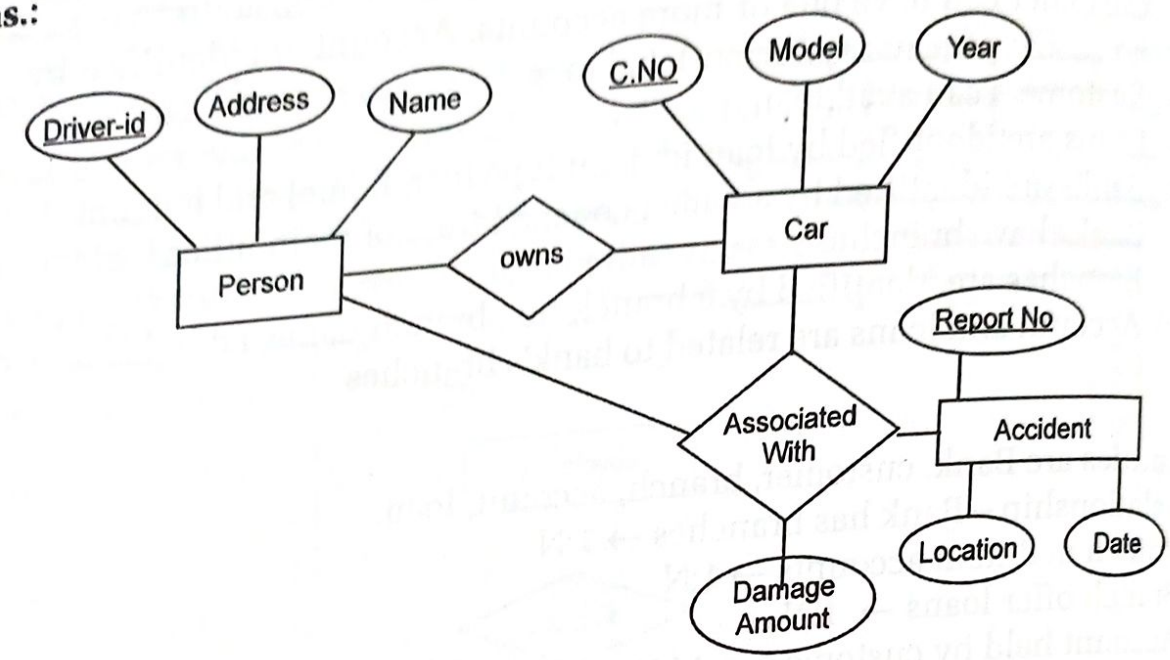


Fig. 2.44: ER Diagram of Car Insurance Company

Example 3: Reduce E-R Diagram of car insurance company of example2 into tables.

Ans:

- Person(Driver_id, Name, Address)
- Car(C.No, Model, Year)
- Accident (ReportNo, Location, Date)
- Associated(Driver_id, C.No, ReportNo, DamageAmount)

Example 4: Construct an E-R diagram for a hospital with a set of patients and a Associate with each patient, a log of various tests and examination conducted. **(MDU, Dec. 2009)**

Ans.

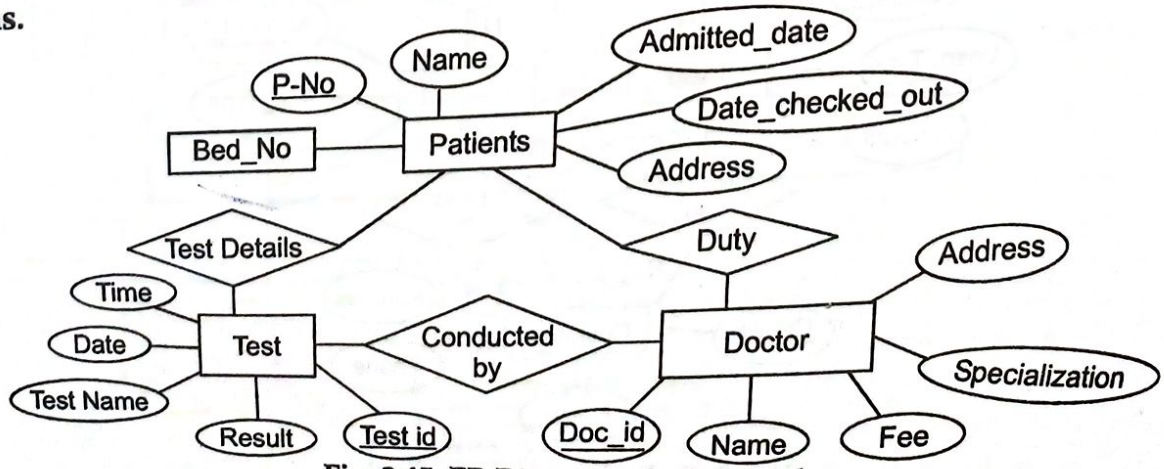


Fig. 2.45: ER Diagram of a Hospital

Example 5: Reduce E-R Diagram of example 4 into tables.

Ans:

Patients(P_No, Name, Bed_No, Address, Admitted_date,Date_checked_out)
Doctor(Doc_id, Name,Fee, Specialization,Address)
Test(Test_id,TestName, Date, Time, Result)
Duty(Doc_id,P_No)
Test_Details(P_No,Test_id)
Conducted_by(Test_id,Doc_id)

Example 6: Construct an E-R diagram for a company having following description. **(GGSIPU, 2013)**

1. There are several department in the company. Each department may have several location.
2. A manager control a particular department.
3. Each department is associated with number of project.
4. An employee works is only one department but can work on several project. We also keep track of number of hours worked by an employee on a single project.
5. Each employee has dependent.

Ans:

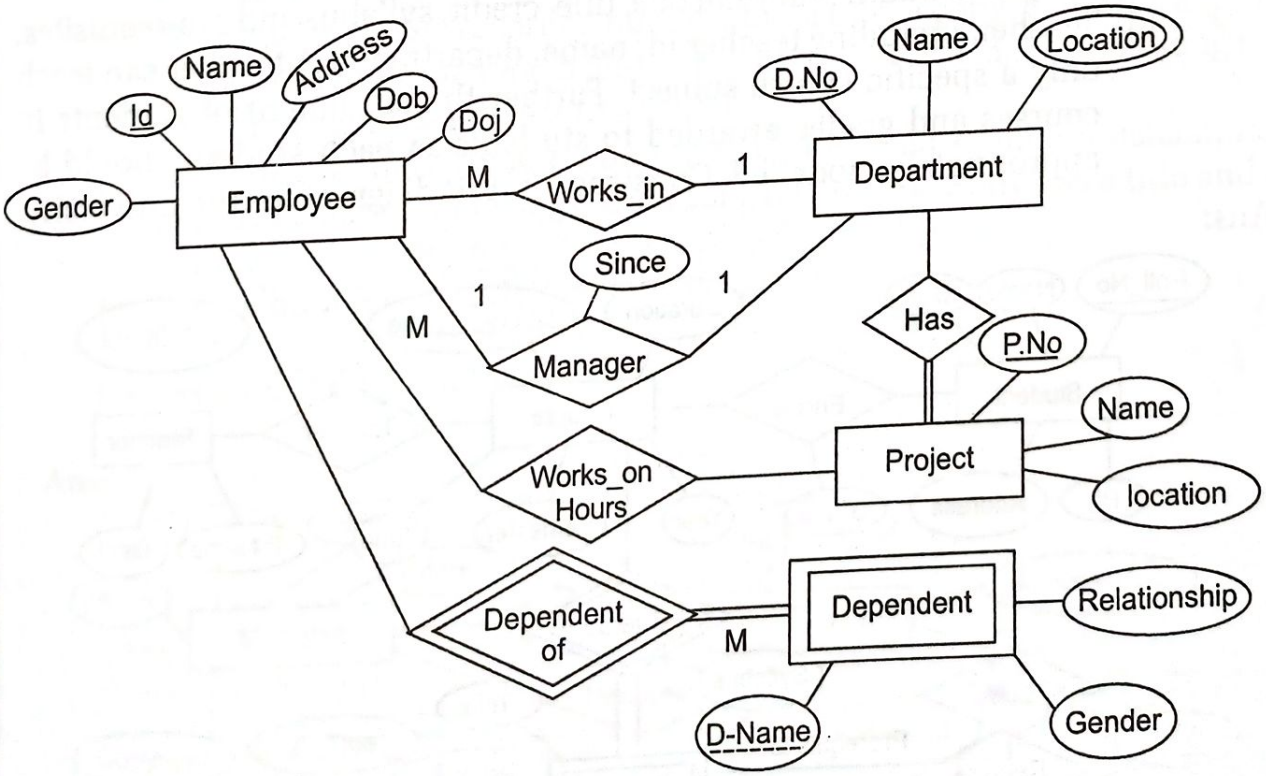


Fig. 2.46: ER Diagram of a Company

Example 7: Draw a E-R Diagram for a hospital **(GGSIPU, 2007)**

Ans:

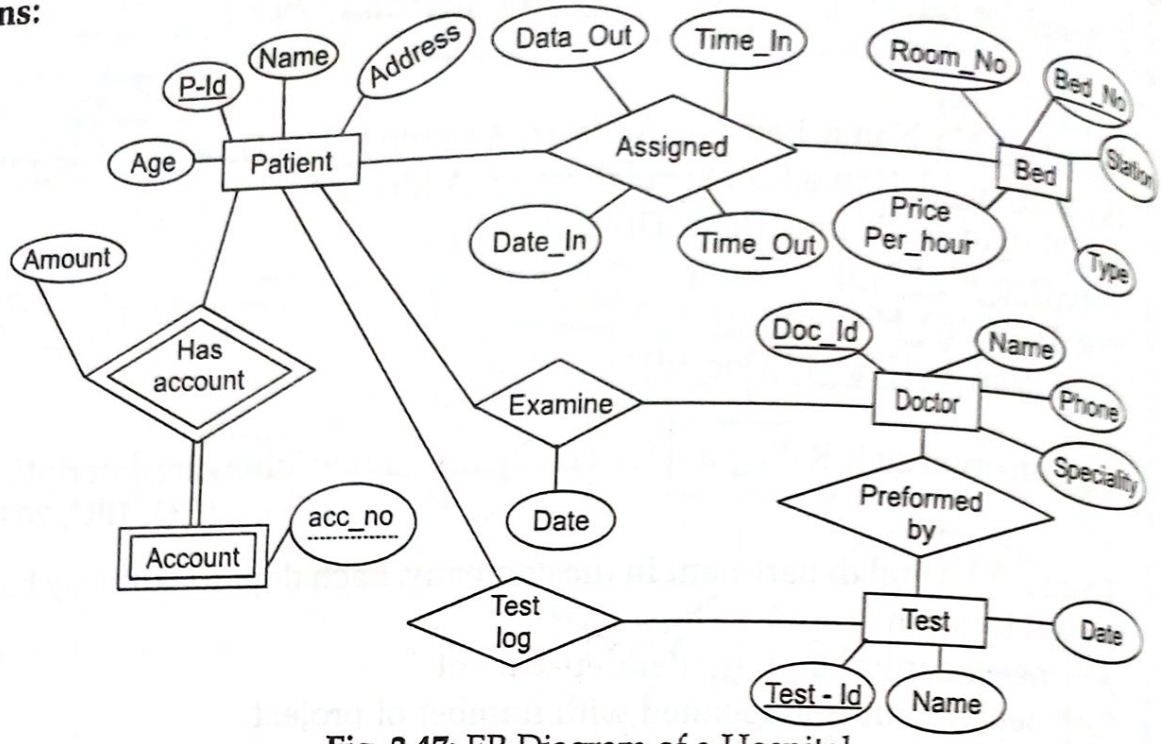


Fig. 2.47: ER Diagram of a Hospital

Example 8: A university maintains data about following entities:

(a) Students, including roll no., name, dob, address, telephone no.

(b) Course (B. Tech, BCA, BBA, MBA) including duration, course name, year, semester time.

(c) Subject including subject-code, title, credit, syllabus and pre-requisites.

(d) Teacher, including teacher id, name, department. A teacher can teach only a specific course subject. Further the enrolment of students in courses and grades awarded to students in each student should be appropriately modelled. Construct an E-R diagram for the university.

Ans:

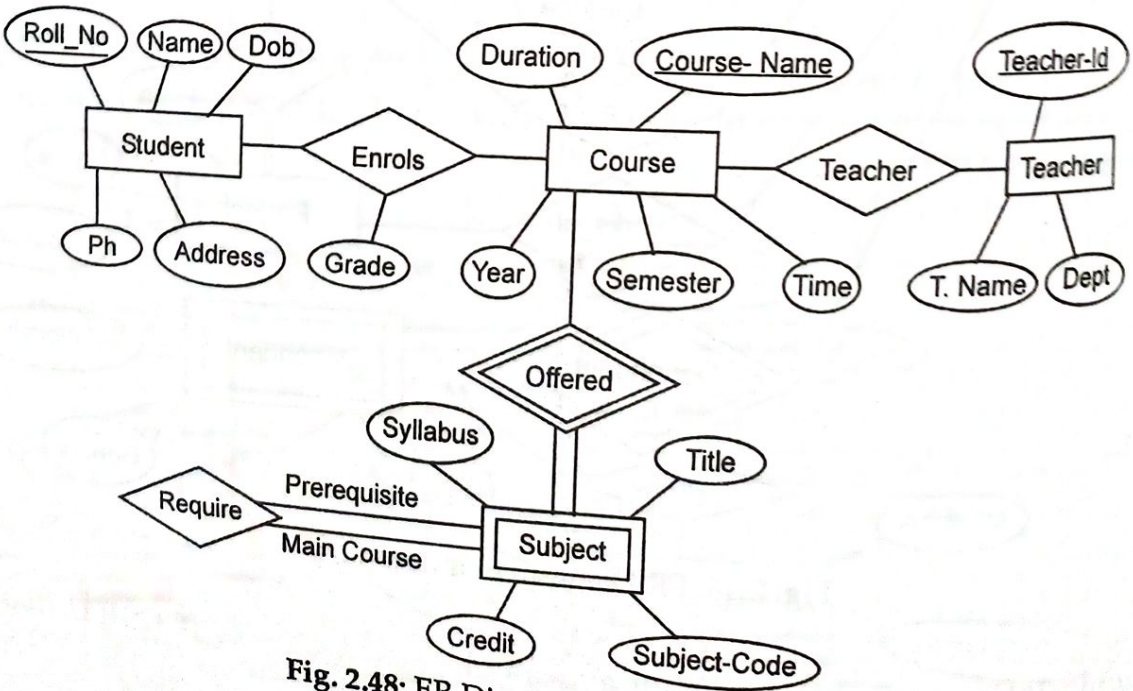


Fig. 2.48: ER Diagram of a University

Example 9: Design an E-R diagram that keep track of your favourite sports team. **(GGSIPU, 2009)**

Ans:

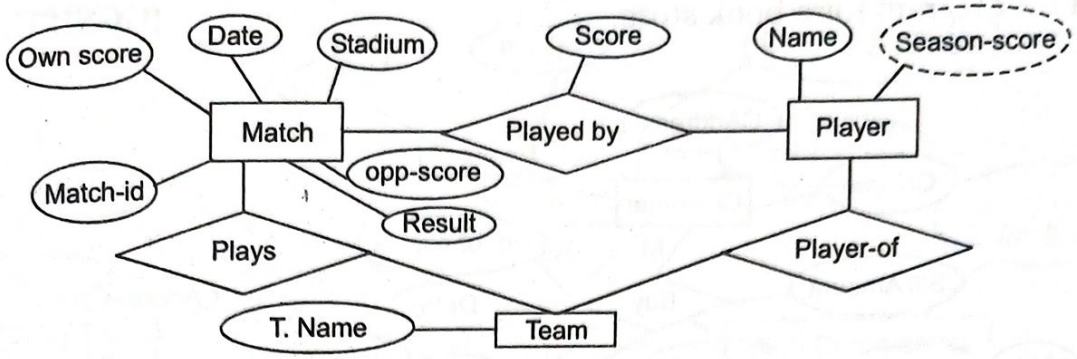


Fig. 2.49: ER Diagram of a Sports Team

Example 10: Sony has decide to store information about musicians who perform on its albums in a database. The company has following requirements: **(PTU, 2012)**

(a) Each musician that records at Sony has an Id, address and a phone number. Each musician may plays several instruments and a given instrument may be played by serial musicians.
(b) Each instruments that is used in songs recorded at Sony has a name and a musical key.
(c) Each album that is recorded on Sony has a title, a copyright date, a format and album identifier. Each album has a number of songs but no song may appear or more than once in an album.
(d) Each song is performed by one or more musicians and a musician may perform a number of songs. Each song recorded at Sony has a title and an author.
(e) Each album has exactly one musician.

Design an E-R diagram for it.

Ans:

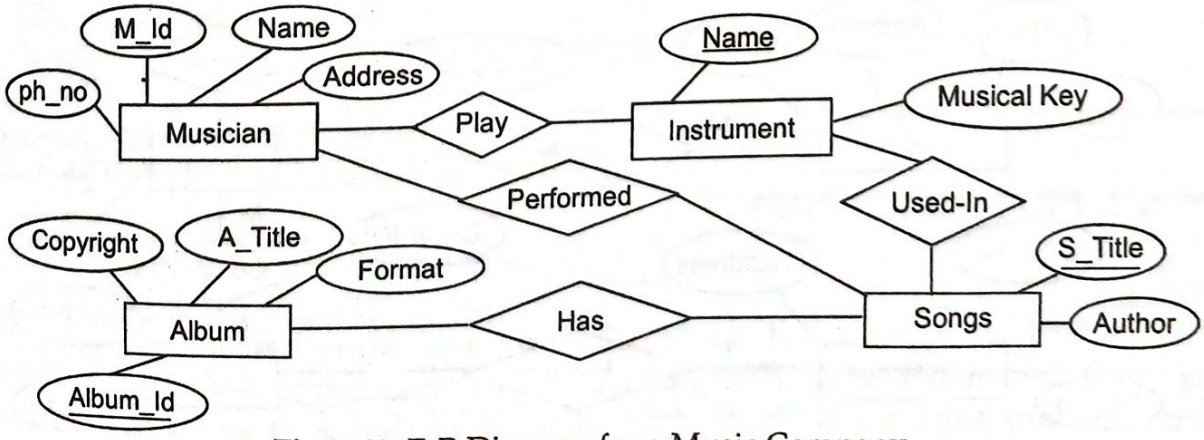


Fig. 2.50: E-R Diagram for a Music Company

Example 11: Draw a ER diagram for a book store. The entities include customer, author, book, publisher etc. A author can review a book and give his rating. Define attribute that define all the entities and also establish relationship between various entities.

or

Draw a ER diagram for a book store. **(GGSIPU, 2012)**

Ans.

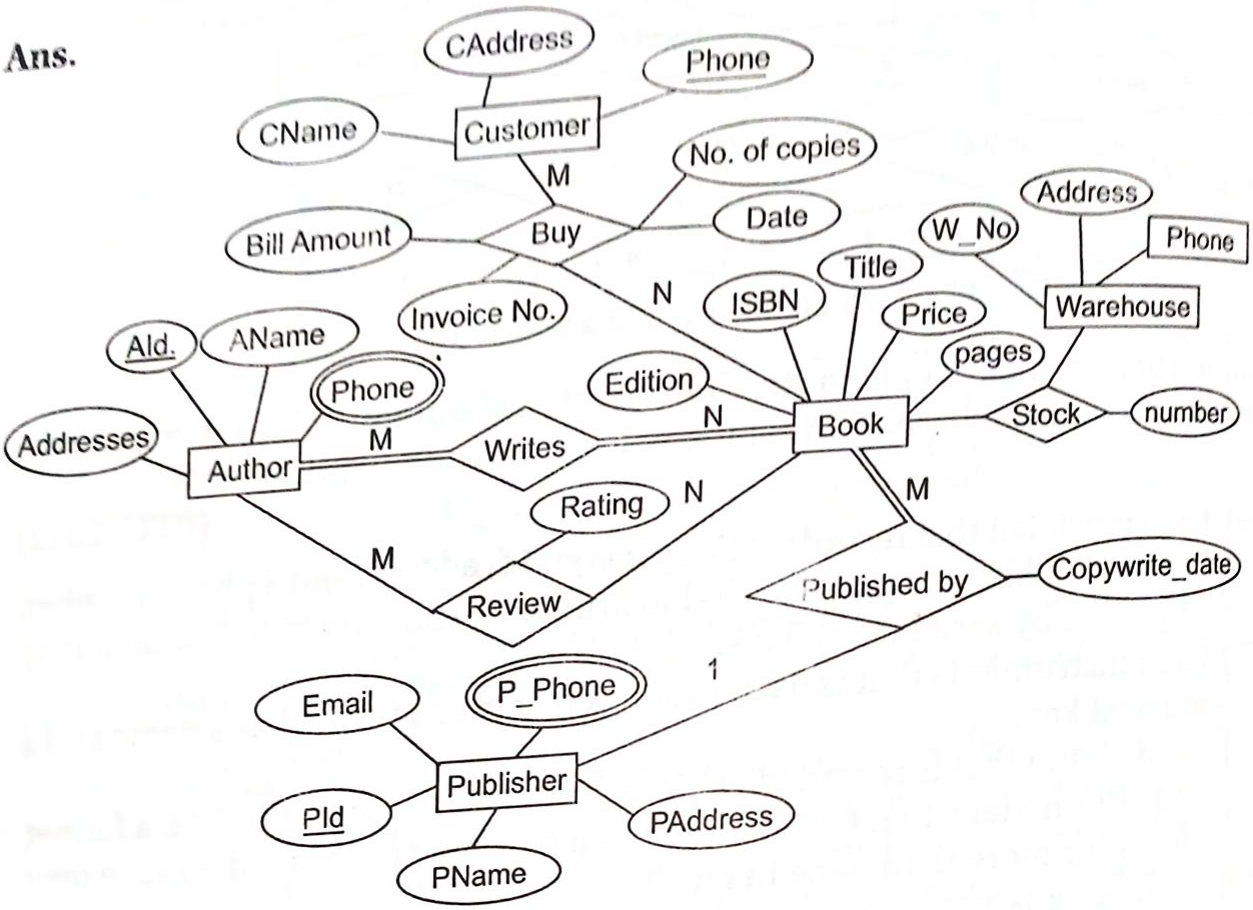


Fig. 2.51: ER Diagram for Book Store

Example 12: Draw a ER diagram of a departmental store that sales different items. Items are supplied by suppliers. Customer can place order of items.

Ans.

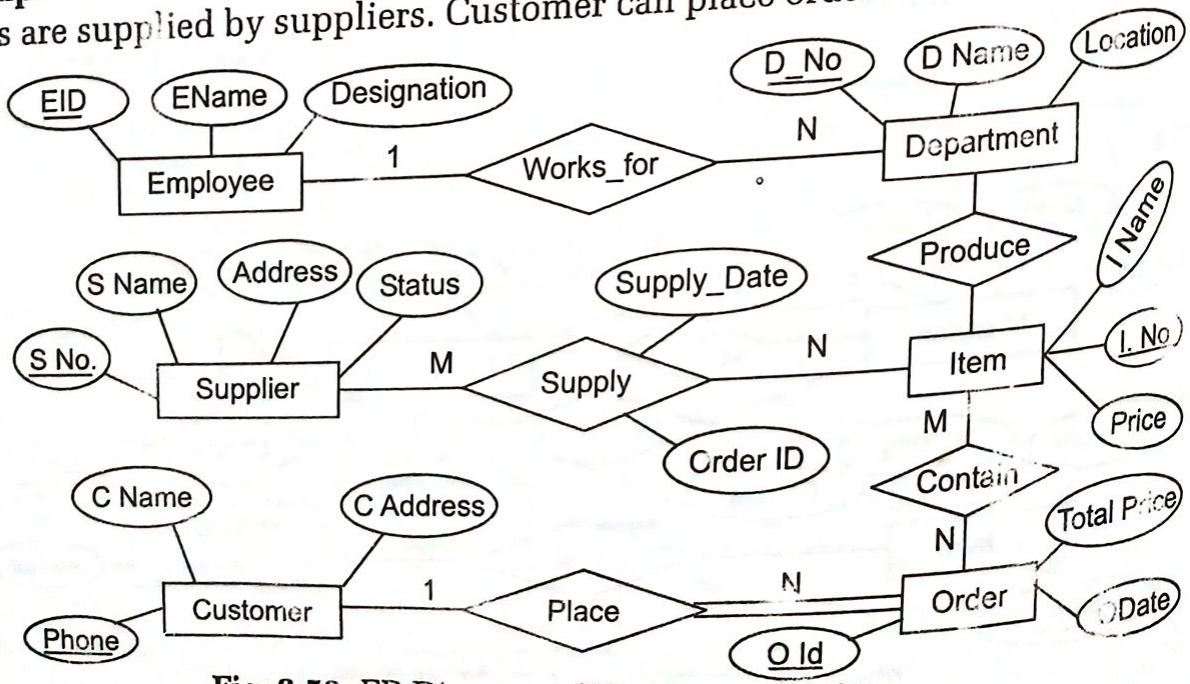


Fig. 2.52: ER Diagram of Departmental Store

Example 13: Design a generalization and specialization hierarchy for a motor vehicle sales company. The company sells motorcycles, passenger cars, cars and buses. **(GGSIPU, 2010)**

Ans.

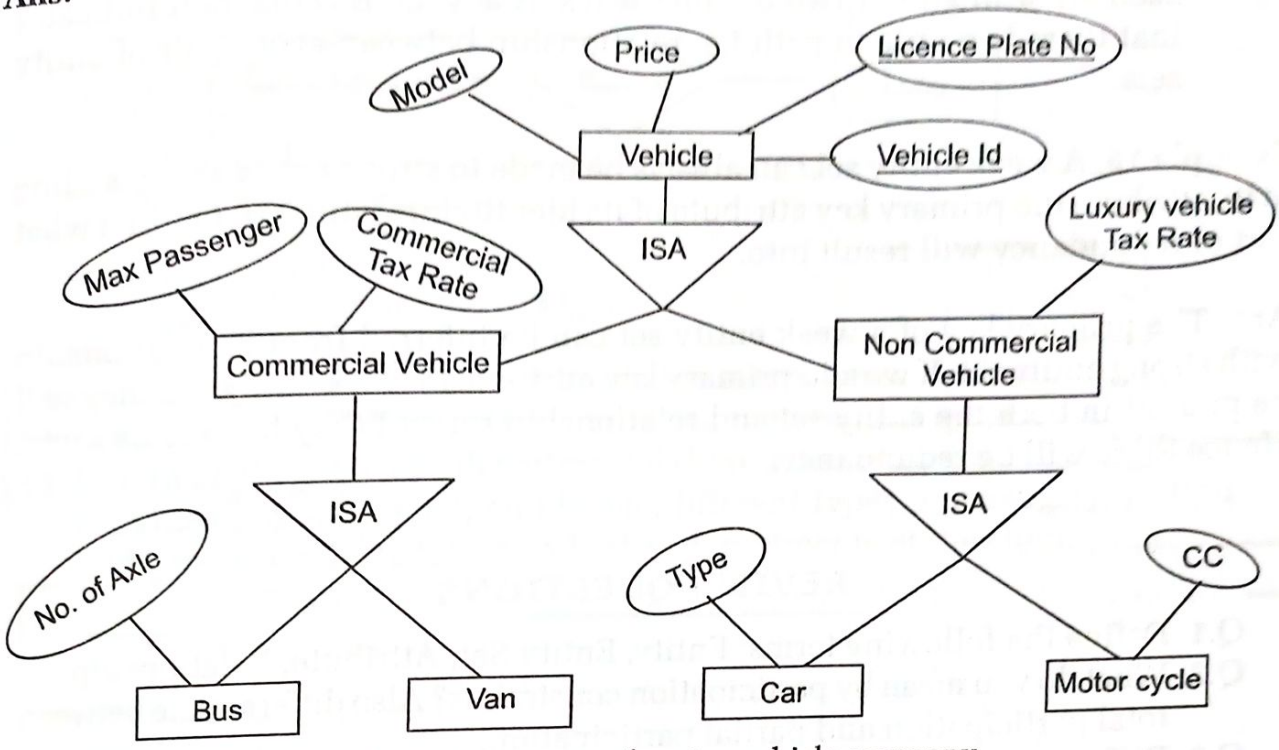


Fig. 2.53: ER Diagram of motor vehicle company

Example 14: We can convert any weak. entity set to a strong entity set by simply adding appropriate attributes. Why, then do we have a weak entity set? **(GGSIPU, 2007)**

Ans: Weak entity set are required because of following reasons:

- Weak entity set reflects the logical streature of an entity being dependent on another entity.
- Weak entities can be deleted automatically when their strong entity set to which they are associated, is deleted.
- Data dulication and inconsistencies may occur if we duplicate the key of the strong entity set.
- Weak entities can be strored physically with their strong entities.

Example 15: An E-R diagram can be viewed as a graph. What do the following mean in term of the structure of an enterprise scheme? **(GGSIPU, 2009, UPTU, 2009)**

a) The graph is disconnected

Ans. A disconnected graph is a graph in which there are node that are not connected. Since E-R diagram is viewed as a graph, then this means there are pair of entity sets that are unrelated to each other. If we split the grph into

connected components, then we have separate database corresponding to each connected components.

b) The graph is acyclic.
A cycle indicate that every pair of entity sets on the cycle are related to each ether in atleast two distinct ways. A acyclic E-R diagram indicates that there is a unique path i.e. relationship between every pair of entity sets.

Example 16: A weak entity set can always be made to strong entity set by adding to its attribute the primary key attribute of its identifying entity set. Outline what sort of redundancy will result into.

Ans. The primary key of a weak entity set can be inferred from its relationship with strong entity set. If we add primary key attribute to weak entity set, they will be present in both the entity set and relationship set and they have to be same. Hence there will be redundancy.